NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

MBA PROFESSIONAL REPORT

A Baseline Analysis Of In-Transit Shipping Time Into And Through The Fifth Fleet Area Of Operation With Respect To The Supply Chain Last Nautical Mile

---

By: Cass Madson and Jared Mauldin

December 2011

Advisors: Geraldo Ferrer, Kenneth Doerr

THIS PAGE INTENTIONALLY LEFT BLANK

REPORT DOCUMENTATION PAGE			*Form Approved OMB No. 0704-0188*
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instruction, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188) Washington DC 20503.			
1. AGENCY USE ONLY *(Leave blank)*	**2. REPORT DATE** December 2011	**3. REPORT TYPE AND DATES COVERED** MBA Professional Report	
4. TITLE AND SUBTITLE A Baseline Analysis Of In-Transit Shipping Time Into And Through The Fifth Fleet Area Of Operation With Respect To The Supply Chain Last Nautical Mile			**5. FUNDING NUMBERS**
6. AUTHOR(S) Cass Madson and Jared Mauldin			
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Postgraduate School Monterey, CA 93943-5000			**8. PERFORMING ORGANIZATION REPORT NUMBER**
9. SPONSORING /MONITORING AGENCY NAME(S) AND ADDRESS(ES) Naval Supply Systems Command, 5450 Carlisle Pike, P.O. Box 2050 Mechanicsburg, PA 17055-0791			**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**
11. SUPPLEMENTARY NOTES The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government. IRB Protocol number ______N/A________.			
12a. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release; distribution is unlimited			**12b. DISTRIBUTION CODE** A
13. ABSTRACT (maximum 200 words) In FY 2010, the Department of Defense (DoD) spent more than $210 Billion on supply chain management. However, the Government Accountability Office has identified DoD supply chain management as a high-risk area, specifically forecasting, asset visibility, and materiel distribution. Additionally, the DoD has not developed the means to measure the effectiveness of implemented actions or defined root causes as they pertain to the warfighter. The purpose of this study is to examine current supply chain practices and procedures within the Department of the Navy (DoN). The goal is to provide a baseline for comparing the in-transit shipping times of three shipping priority categories to identify potential problem areas within the DoN logistics network, specifically within the Fifth Fleet area of operation (AOR). Identifying potential weaknesses within the supply chain provides suggestions for further study to best identify cost effective ways to improve material movement, processes, and to increase the readiness of the warfighter.			
14. SUBJECT TERMS Supply Chain Visibility; Last-Mile Logistics; United States Fifth Fleet			**15. NUMBER OF PAGES** 79
			16. PRICE CODE
17. SECURITY CLASSIFICATION OF REPORT Unclassified	**18. SECURITY CLASSIFICATION OF THIS PAGE** Unclassified	**19. SECURITY CLASSIFICATION OF ABSTRACT** Unclassified	**20. LIMITATION OF ABSTRACT** UU

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. 239-18

THIS PAGE INTENTIONALLY LEFT BLANK

Approved for public release; distribution is unlimited

A BASELINE ANALYSIS OF IN-TRANSIT SHIPPING TIME INTO AND THROUGH THE FIFTH FLEET AREA OF OPERATION WITH RESPECT TO THE SUPPLY CHAIN LAST NAUTICAL MILE

Cass Madson, Lieutenant Commander, United States Navy
Jared Mauldin, Lieutenant, United States Navy

Submitted in partial fulfillment of the requirements for the degree of

MASTER OF BUSINESS ADMINISTRATION

from the

NAVAL POSTGRADUATE SCHOOL
December 2011

Authors: ____
Cass Madson

____
Jared Mauldin

Approved by: ____
Geraldo Ferrer, Lead Advisor

____
Kenneth Doerr, Support Advisor

____
William R. Gates, Dean
Graduate School of Business and Public Policy

THIS PAGE INTENTIONALLY LEFT BLANK

A BASELINE ANALYSIS OF IN-TRANSIT SHIPPING TIME INTO AND THROUGH THE FIFTH FLEET AREA OF OPERATION WITH RESPECT TO THE SUPPLY CHAIN LAST NAUTICAL MILE

ABSTRACT

In FY 2010, the Department of Defense (DoD) spent more than $210 Billion on supply chain management. However, the Government Accountability Office has identified DoD supply chain management as a high-risk area, specifically forecasting, asset visibility, and materiel distribution. Additionally, the DoD has not developed the means to measure the effectiveness of implemented actions or defined root causes as they pertain to the warfighter. The purpose of this study is to examine current supply chain practices and procedures within the Department of the Navy (DoN). The goal is to provide a baseline for comparing the in-transit shipping times of three shipping priority categories to identify potential problem areas within the DoN logistics network, specifically within the Fifth Fleet area of operation (AOR). Identifying potential weaknesses within the supply chain provides suggestions for further study to best identify cost effective ways to improve material movement, processes, and to increase the readiness of the warfighter.

THIS PAGE INTENTIONALLY LEFT BLANK

TABLE OF CONTENTS

THIS PAGE INTENTIONALLY LEFT BLANK

LIST OF FIGURES

THIS PAGE INTENTIONALLY LEFT BLANK

LIST OF TABLES

THIS PAGE INTENTIONALLY LEFT BLANK

LIST OF ACRONYMS AND ABBREVIATIONS

AMC	Air Mobility Command
AOR	Area of Operation
COD	Carrier Onboard Delivery
CONREP	Connected Replenishment
DoD	Department of Defense
DoN	Department of the Navy
GAO	Government Accountability Office
IUID	Item Unique Identification
MSC	Military Sealift Command
NAVSUP	Naval Supply Systems Command
POD	Port of Debarkation
RDD	Required Delivery Date
RFID	Radio Frequency Identification
U.A.E.	United Arab Emirates
UNREP	Underway Replenishment
USCENTCOM	U.S. Central Command
VERTREP	Vertical Replenishment
VOD	Vertical Onboard Delivery

THIS PAGE INTENTIONALLY LEFT BLANK

ACKNOWLEDGMENTS

The authors would like to thank all those who assisted in the completion of this project, most notably Professor Geraldo Ferrer and Professor Kenneth Doerr for their help and guidance through this process. Your instruction and support enabled us to accomplish this project. Beyond the scope of the project, you have given us tools we may employ in our future assignments. Additionally, the researchers would like to thank and acknowledge Captain Brian Drapp and Lieutenant Commander Scott Stahl for their direction and support of this project. Special thanks to Mr. Donald McNeely and his team at the NAVSUP Operational Logistics Center for their insight into DoN supply chain issues, and specifically, Ms. Kacey Higgins for her assistance with requisition data in the Fifth Fleet area of operation. Finally, we would like to thank Captain Jesús Cantú, Commander Joel Tiu, Commander Edward Simpson, and Lieutenant Jakenberg Almuete for assisting in our understanding of the Fifth Fleet logistics process.

LCDR Cass Madson

LT Jared Mauldin

I wish to thank my parents, Edward and Lynda, for all of their guidance and understanding, which has gotten me to where and who I am. I would particularly like to thank my wonderful wife, Laura and my little ones, Abigail, Roxy, Gracie and Monty, without whose patience, none of this would have been possible.

LCDR Cass Madson

I would like to thank my family, friends, and professors for their support and patience that made this project a reality. I would especially like to thank my wife, Katie, and my girls, Maggie and Bernie—without you, this accomplishment would not have been possible.

LT Jared Mauldin

THIS PAGE INTENTIONALLY LEFT BLANK

I. INTRODUCTION

A. BACKGROUND

In FY 2010, the Department of Defense (DoD) spent more than $210 Billion on logistics and supply chain management. Yet long-standing weaknesses exist that result in DoD supply chain management being assessed as a "high risk" area by the Government Accountability Office (GAO) (Government Accountability Office [GAO], 2011a). The GAO identified three areas within DoD's supply chain management that led to the poor assessment: requirements forecasting, asset visibility, and materiel distribution. To remove supply chain management from the GAO's list of high-risk areas, the DoD need to develop and implement specific corrective action plans that not only address identified weaknesses, but also set in place metrics and oversight processes that prevent those weaknesses from reappearing. According to the GAO, the DoD has not developed plans that sufficiently meet these requirements (Government Accountability Office [GAO], 2011b). Specifically, although the DoD has developed plans for corrective actions, it has not developed a means to evaluate and measure the effectiveness of the implemented actions. Additionally, the DoD has not effectively defined root causes or effective solutions as they pertain to the warfighter. For instance, the Army has implemented a $2.6 billion Enterprise Resource Planning system to improve forecasting, but has not seen expected benefits due to data processing issues (GAO, 2011b). Lack of reliable process and cost data was another area addressed in the GAO report, and contributed significantly to the high risk classification. Without reliable process and cost data, even well thought out implementation plans carry greater risk.

B. PURPOSE

This study examines current supply chain practices and procedures within the Department of the Navy (DoN). The goal is to provide a baseline for in-transit shipping times for three shipping priority categories to identify potential problem areas within the DoN logistics network within the Fifth Fleet Area of Operation (AOR). Identifying potential weaknesses within the supply chain provides suggestions for areas of further

study to best identify cost effective ways to improve material movement practices and processes and to increase the readiness of the warfighter.

C. RESEARCH QUESTIONS

1. What variability exists in the supply chain from material shipping to the last geographic location of in transit visibility, and in the last nautical mile?

2. What are the relationships between the shipping times of different priorities within the two applicable segments of the supply chain?

D. SUMMARY

This study is divided into six chapters. Chapter I describes the background and reason for the study, outlines the goals for the study, and gives the research questions. Chapter II reviews relevant literature. Chapter III identifies the current supply chain into and through the Fifth Fleet AOR, clarifies applicable supply chain issues, and outlines the challenges and limitations faced by Department of Defense (DoD) logisticians. Chapter IV describes the dataset and methodology used to answer the research questions. Chapter V describes the data analysis performed. Chapter VI provides conclusions based on the data analysis and recommendations for further study.

II. LITERATURE REVIEW

There are scholarly aspects relevant to this study that should be reviewed. Supply chain visibility is not only a priority for DoD but is extremely important for civilian sector businesses. As a result numerous studies have been undertaken to understand and improve supply chain visibility practices. Emergency logistics is an area that has not been as widely explored. However, its dynamic environment parallels much of what the DoD sees in its operations. Finally, last-mile delivery has become an increasingly important subject for the business world as companies attempt to distinguish themselves from their competitors. While DoD does not have competitors, last-mile visibility proves to be the most challenging part of its supply chain. The following sections delve into some of the most relevant research and articles on these topics.

A. SUPPLY CHAIN VISIBILITY

GAO conducted a review of DoD Supply Chain Management and published its findings in January 2009. They found that while DoD has produced several documents aimed at improving supply chain management, there were three areas in which this roadmap could be more effective. The GAO recommended identifying gaps in logistics capabilities, establishing outcome-based performance objectives and defining who is responsible for and how integration of the roadmap with logistics decision-making processes would be accomplished. Additionally, they acknowledged the promise of item unique identification (IUID) and radio frequency identification (RFID) technologies as possible ways to improve asset visibility (GAO, 2009).

Research by Caridi, Crippa, Perego, Sianesi and Tumino (2010) used a model to quantify visibility and measure its effects on supply chain performance. They found not only that increased visibility improves supply chain performance but also developed a method for managers to target low visibility areas (Caridi, Crippa, Perego, Sianesi & Tumino, 2010).

Trebilcock (2010) discusses seven areas of supply chain management that have seen dramatic increases in visibility due to technological breakthroughs. These areas are:

warehouse management systems, warehouse control systems, manufacturing execution systems, asset management, yard management systems, and, most relevant to this study, transportation management systems. While he discusses how visibility affects businesses, his assertion that visibility effects operations is also relevant to DoD. He also proposes that most recent innovations in supply chain management have been driven by visibility (Trebilcock, 2010).

B. EMERGENCY LOGISTICS

Banomyong and Sopadang (2010) developed a model as a conceptual framework for improving emergency logistics response. They also developed a simulation to test their model against a real world scenario. While acknowledging the limitations of their simulation, they believe their model can be a useful tool for logistics decision makers (Banomyong & Sopadang, (2010).

In their research, Wei-hua, Xue-cai, Zheng-xu, and Peng (2011) use a mathematical model to examine an emergency order allocation mechanism in order to help managers understand and deal with problems in the case of an emergency. Implementation of their model in a practical setting has proven to be successful for a logistics company in China (Wei-hua, Xue-cai, Zheng-xu, & Peng, 2011).

C. LAST MILE DELIVERY

Boyer, Prud'homme, and Chung (2009) investigated the relationships customer density and delivery windows have on efficiency. They found through use of a simulation that while increasing customer density and/or length of delivery windows increased efficiency, it did so at a decreasing rate. This indicates that there is an optimal point between customer density or delivery window and efficiency (Boyer, Prud'homme, & Chung, 2009).

O’Shea (2009) believes the last-mile is the most important but that companies place most of their attention at the beginning of their supply chains. He regards the end of the supply chain as the most inefficient piece. He concludes that investment in true

end-to-end visibility is what will distinguish successful companies from failures (O'Shea, 2009). Similarly, Cottrill (2000) discusses how successfully conquering the last-mile can make or break a company.

Germain (2004) ties last-mile delivery to supply chain visibility. He discusses the benefits of visibility including reduced cost, improved efficiency and increased access to actionable data for managers. He also explains why, despite the benefits, companies are reluctant to implement it. This, he notes, is due to perceived financial and operational risks faced by its implementation. Managers cannot see a clear return on investment and adding additional pieces to already complicated supply chains could cause unneeded difficulties. He concludes that these perceived risks are fictitious and implementation leads to opening up the last-mile (Germain, 2004).

THIS PAGE INTENTIONALLY LEFT BLANK

III. BACKGROUND

A. GENERAL INFORMATION

The U.S. Department of Defense (DOD) divides command and control responsibility into nine Combatant Commands. Six of the Combatant Commands are geographical; three are functional. At a minimum, each Combatant Command is divided into Service components. This project focuses analysis on the supply chain that ends at U.S. Navy afloat units in the Area of Responsibility (AOR) of the Navy component of the U.S. Central Command (USCENTCOM), the U.S. Fifth Fleet.

USCENTCOM's AOR roughly covers Egypt, the Arabian Peninsula (except Israel), western Asia (except Turkey), south of Russia and west of China and India, including the international waters of the Red Sea and the Arabian Sea (United States Central Command [USCENTCOM], n.d.). See Figure 1.

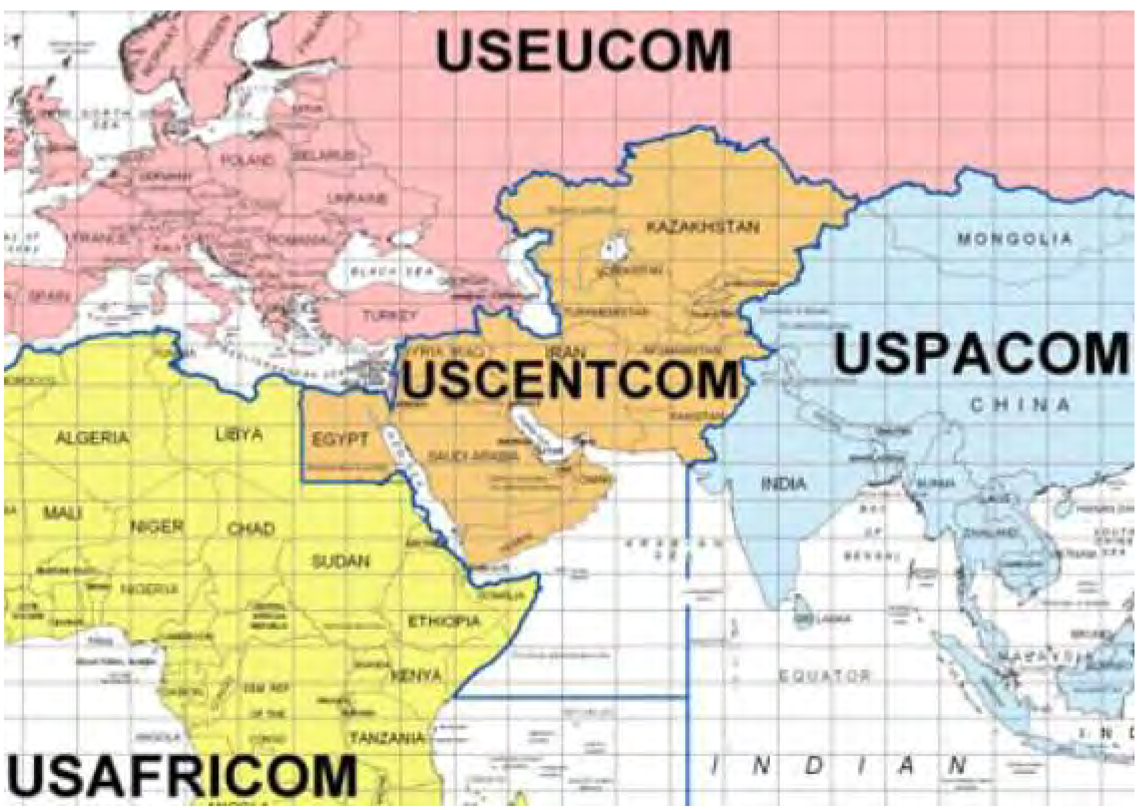

Figure 1. U.S. Central Command Area of Responsibility (From United States Central Command [USCENTCOM], n.d.)

Critical to the analysis of the Fifth Fleet supply chain is a thorough understanding of how material flows through the AOR. This understanding must include the methods used to ship material into and throughout Fifth Fleet. Additionally, identifying the points at which the material enters the area and intermediate stops before final delivery is integral to complete understanding the supply chain.

In general, a supply chain can be thought of as a decision-making “cone.” There are usually numerous options for moving material early; however, options typically decrease as the material approaches its final destination. These decisions can be the method of transportation or the intermediate destinations through which the material will flow.

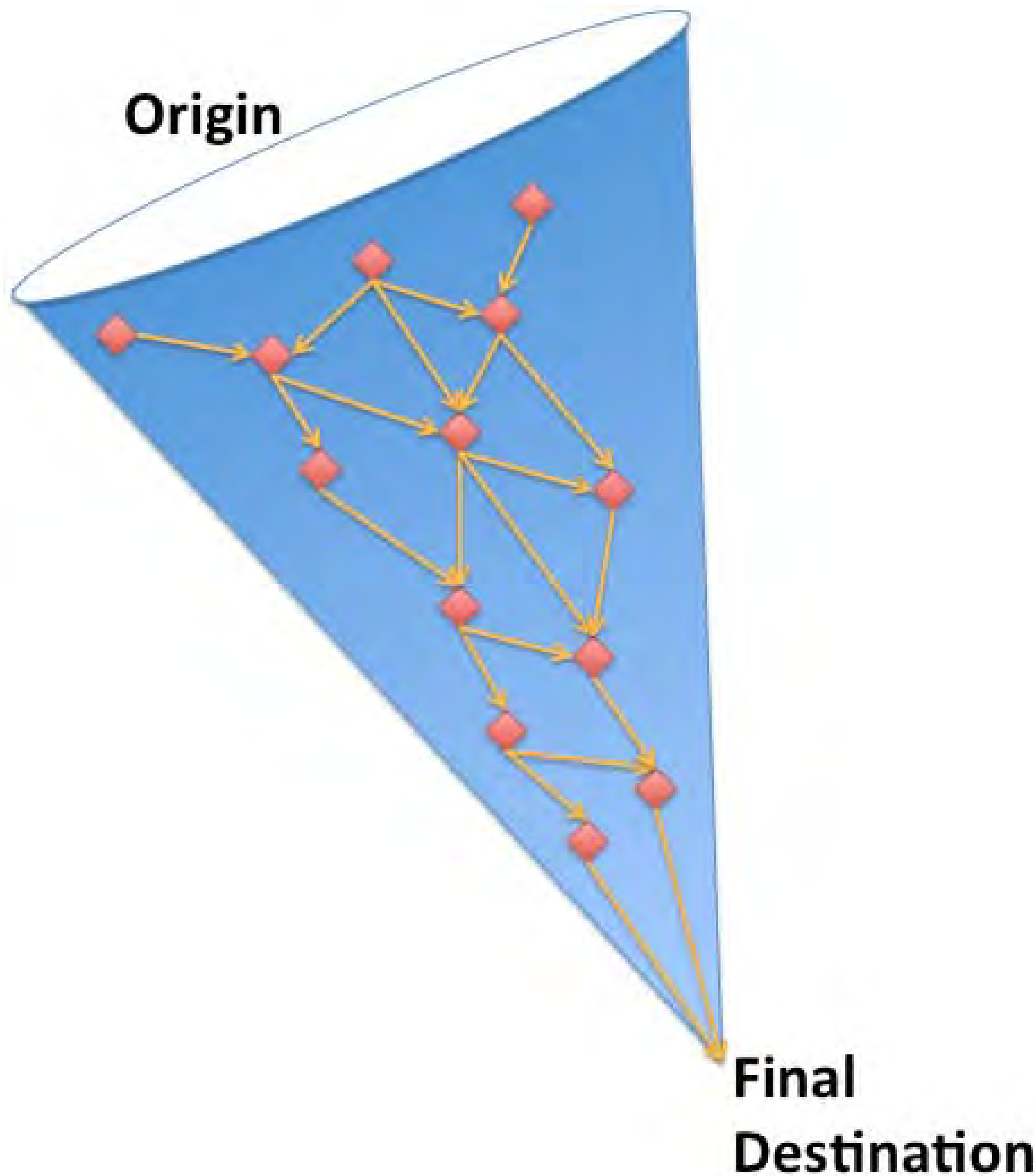

Figure 2. Supply Chain "Cone"

B. U.S. FIFTH FLEET SUPPLY CHAIN

1. Pre Arrival

Material destined to the Fifth Fleet can originate at a manufacturer or a supply depot. The material is moved from its origin to a distribution center for shipment to Fifth Fleet. Few routing decisions are made with respect to where the material is shipped prior

to arrival in the AOR. See Figure 3. Unlike the "cone" model, in the Persian Gulf, most routing decisions are made in theater. This is due to the fact that unit position and schedule is often fluid and operational planners in Fifth Fleet have access to the most current information. In addition, security concerns make unit movements classified.

Prior to being shipped by the Air Mobility Command (AMC), material is tagged with an active radio frequency identification (RFID) tag. This material can be tracked using the R-Gates RFID system at locations that possess interrogators capable of reading the tag.

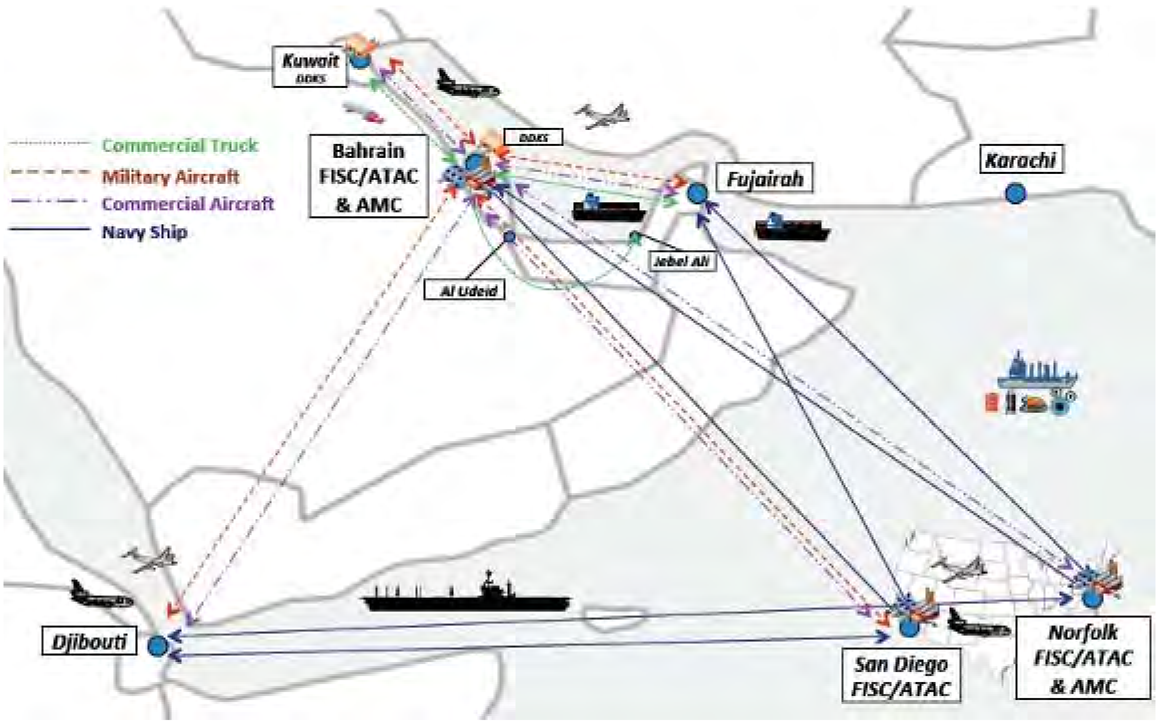

Figure 3. U.S. Fifth Fleet Supply Chain (From NAVSUP, 2011)

2. Arrival in Fifth Fleet

Broadly, material arrives into the AOR via military transport or world wide express (WWX). Worldwide express is the DOD term for commercial shipping companies such as DHL or FedEx. WWX shipments arrive daily. Military transport into the theater can be broken down into airlift and sealift. Airlift by AMC arrives up to three times per week. Military sealift is very limited and occurs on a space available basis.

The main arrival point for AMC material is Bahrain in the Arabian Peninsula. Upon arrival at the Bahrain airport, material is sorted by end user at the airhead warehouse. If the material requires further air transport, it will remain at the airhead warehouse. Any other material is transported to the Navy operated warehouse near the Bahrain waterfront. Material arriving by commercial sealift is usually delivered to Jebel Ali, United Arab Emirates (U.A.E.), however some material does get delivered to the commercial port in Bahrain. Military sealift shipments are unloaded wherever the vessel makes its first port of call, usually Jebel Ali or Bahrain. Most WWX material is delivered to Bahrain, however Jebel Ali, Fujairah, U.A.E., and to a limited extent, Djibouti in the Horn of Africa are also delivery points.

3. In-Theater Movement

Once in theater, CTF-53, the logistics arm of Fifth Fleet, takes over responsibility for transportation. For intermediate movement, CTF-53 uses organic air assets or contracted commercial trucking to move material. Their organic air assets include one C-40 and one C-130. This is the primary means of moving material. The C-40 is a military version of the Boeing 737. It has a range in excess of 3,100 nm while transporting 40,000 lbs. of cargo (United States Navy [USN], 2009a). See Figure 5. The C-130 is an aircraft that has a 2,500 nm range when carrying 25,000 lbs. of cargo (USN, 2009b).

Figure 4. C-130 Hercules (From USN, 2002)

Figure 5. C-40 Clipper (From USN, 2001)

Intermediate stops, those locations between initial arrival in the AOR and the end user, include Jebel Ali, Fujairah, Djibouti and Bahrain. The straight-line distance from Bahrain to Fujairah is approximately 370 miles and Bahrain to Djibouti is approximately 1113 miles (World Airport Codes, n.d.). All of the aforementioned locations are equipped with R-GATES active RFID systems. Material not actively tagged can be manually entered for tracking. These intermediate stops represent the final time that in transit visibility (ITV) is currently available and the final time data is currently collected prior to the end user reporting material receipt.

4. Final Delivery

While final delivery is occasionally made directly to the end user while inport, most material arrives via Carrier Onboard Delivery (COD), Vertical Onboard Delivery (VOD)/ Vertical Replenishment (VERTREP) or by Military Sealift Command (MSC) Underway Replenishment (UNREP) ship. This is commonly referred to the last nautical mile and is the terminal phase of the material's journey.

COD is a method of delivery where a fixed wing aircraft lands on an aircraft carrier to bring personnel, equipment, or supplies. Similarly, VOD delivers personnel, equipment or supplies by utilizing helicopters. This method is typically used typically ships other than aircraft carriers that are equipped with helicopter landing decks.

UNREPs are broken down into two categories, connected replenishments (CONREP) and VERTREP. A CONREP is two ships sailing approximately 150 feet abreast of one another along the same course and connected using high-tension steel cables. A shuttle is mechanically pulled back and forth with pallets slung underneath the shuttle. Hoses can also be attached to the cables to facilitate fuel delivery. See Figure 6. Like VOD, VERTREP utilizes helicopters; however, pallets are lifted externally from the supply ship to the customer vessel. See Figure 9. The customer ship does not need a helicopter landing deck to receive material via VERTREP. Ships can conduct CONREP and VERTREP simultaneously or independently.

Figure 6. U.S. Navy ships conducting a CONREP (From USN, 2004a)

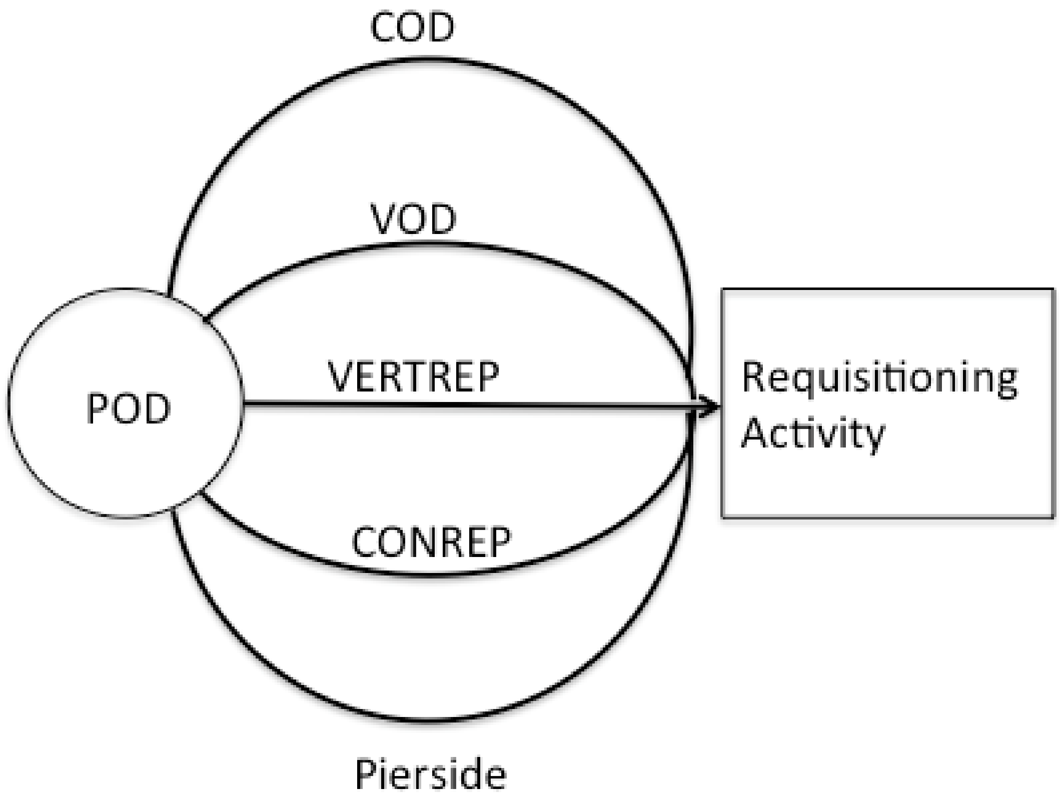

Figure 7. Final Delivery Methods

COD aircraft are C-2 Greyhounds that can (only) deliver directly to aircraft carriers. The C-2 has a 1,300 nm range and a payload of 10,000 pounds (USN, 2009c). The helicopter the U.S. Navy uses for VOD and VERTREP aircraft is H-60, which can carry internal cargo or external loads. The range of an H-60 is 380 nm, however operational regulations drastically reduce that range in practice. An H-60 can carry 2,600 pounds internally or an external load up to 9,000 pounds (USN, 2009d). While the external load capability of the H-60 approaches the capacity of the C-2, external loads are almost never carried more than half a mile. The main drawback to the C-2 is the fact it is fixed wing and, as mentioned above can only land on a runway or aircraft carrier. It also must be within range of an airfield; however, this is less of a problem in the Fifth Fleet due to the geography.

The UNREP ships are Fleet Oilers (T-AO), Fast Combat Support Ships (T-AOE) or Dry Cargo/Ammunition Ships (T-AKE). See Figures 10, 11, and 12. These "supply

ships” conduct CONREPs or, in the case of T-AOEs and T-AKEs, use embarked helicopter detachments for delivery (VOD/VERTREP). Fleet Oilers are not capable of embarking a helicopter detachment and can only be used as a landing/refueling platform (USN, 2007).

Figure 8. C-2 Greyhound (From USN, 2004a)

Figure 9. SH-60 Seahawk conducting VERTREP (From USN, 2004b)

The MSC ships load material in Bahrain, Jebel Ali, Fujairah or Djibouti. Units in the Arabian Gulf are replenished every six to eight days. In the Red Sea, units patrolling UNREP with supply ships every eight to ten days. Ships in the Northern Arabian Sea and Gulf of Oman receive supplies every seven to ten days. Units operating off the Horn of Africa are on a ten to fifteen day replenishment cycle.

Once the end user receives material, the receipt is manually processed and reported to the supply system.

Figure 10. Fleet Oiler (T-AO) (From USN, 2004c)

Figure 11. Fast Combat Support Ship (T-AOE) (From USN, 2004d)

Figure 12. Dry Cargo/Ammunition Ship (T-AKE) (From Military Sealift Command [MSC], n.d.)

THIS PAGE INTENTIONALLY LEFT BLANK

IV. METHODOLOGY

A. DATASET

The data in this study were provided by the NAVSUP Logistics Operations Center, a level III echelon command under the Naval Supply Systems Command (NAVSUP). The NAVSUP Logistics Operations Center is the NAVSUP service provider for transportation, ordnance, and logistics planning coordination. The data includes six months of requisition and shipping data for all afloat assets in the 5th Fleet area of responsibility dated from March 1, 2011 to August 31, 2011, based on requisition order date. The data included 76 variables for each shipment. For this study, the five columns of interest are POD, RDD, Date Shipped, Date POD Received, Date POD Shipped, and Date Received.

- POD – Port of Debarkation, last port through which requisitioned material passes prior to delivery to requisitioning activity.
- RDD – Required Delivery Date assigns a three digit code based on the Julian date of the delivery requirement. For material meeting the criteria for a critical requirement, an RDD of 999 is assigned, and for material not meeting critical criteria but still requiring expedited shipping, an RDD of 777 is assigned (). For the purpose of this study, we have broken the RDDs into three categories; 999, 777, and Other, or all RDDs not meeting the 999 or 777 criteria.
- Date Shipped – Date requisitioned material physically shipped from its point of origin.
- Date POD Received – Date requisitioned material was received at the POD.
- Date POD Shipped – Date requisitioned material was shipped from the POD.
- Date Received – Date requisitioned material was received by requisitioning guide.

The original dataset included 37,781 requisitions. Of the original data, approximately 26% were removed prior to analysis. The set was refined by eliminating data that were missing information, erroneous, or beyond the scope of the study. Because such a large percentage of the data had to be removed, histograms were developed to display any trends that may have appeared relating the missing and erroneous data to the

location of the POD, or the priority assigned. While there were some differences in the percentage of removed data in relation to POD location or priority, no difference was great enough to suggest a bias. The histograms are provided in Figures 13 and 14.

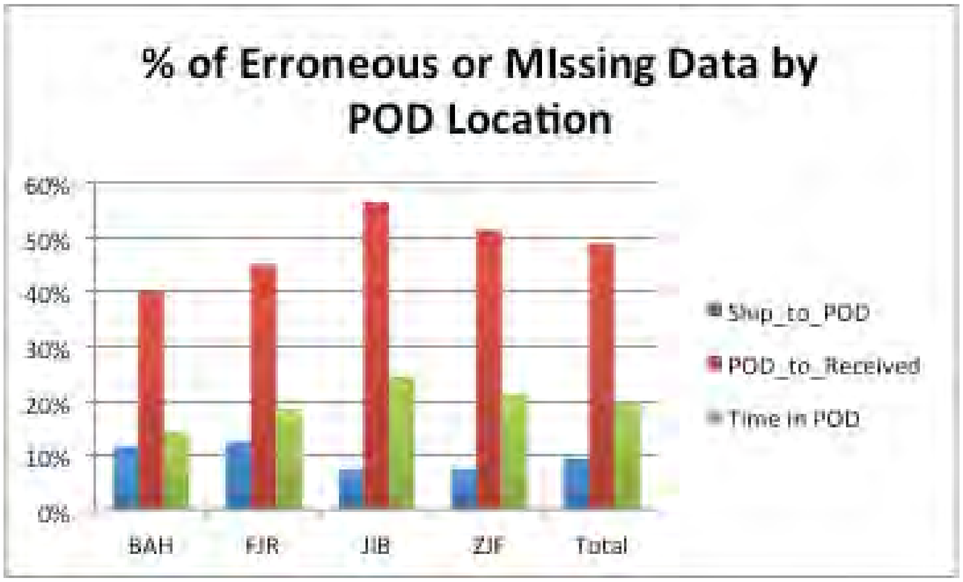

Figure 13. Percentage of Erroneous or Missing Data by POD Location

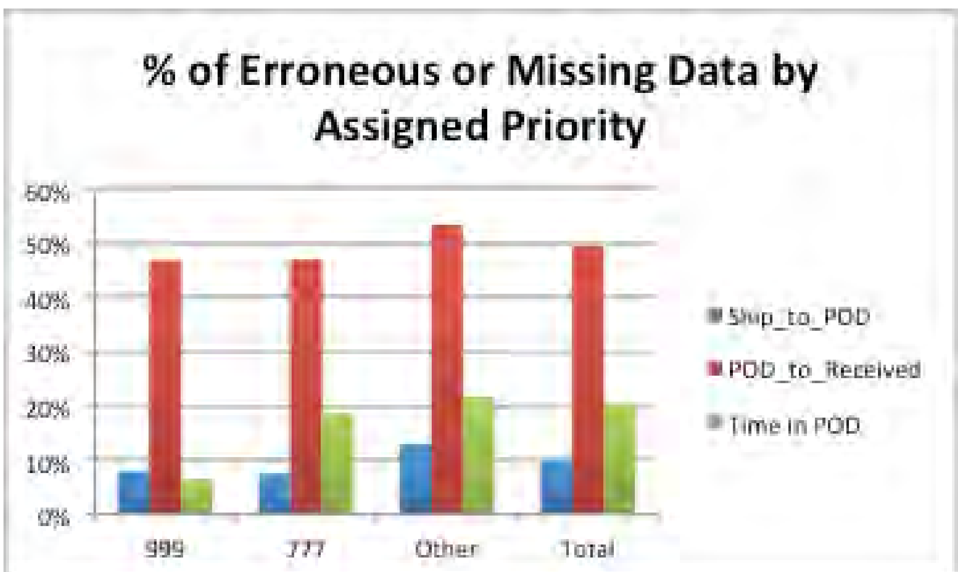

Figure 14. Percentage of Erroneous or Missing Data by Assigned Priority

Missing information was primarily missing POD ship dates, most likely due to inconsistent manual data entry procedures at Naval forward logistics sites. Analysis of these procedures was deemed beyond the scope of this study and the data were removed. Data with a requisitioning activity location other than 5th Fleet were also deemed to be beyond the scope of the study and were removed. Some data were deemed erroneous because of negative processing or shipping times, and were removed. These data were then sorted into four subsets based on location of POD. Table 3.1 provides the location of the PODs.

POD Aerial Ports	
BAH	Bahrain (Kingdom of Bahrain)
FJR	Fujairah (United Arab Emirites)
JIB	Djibouti (Djibouti)
ZJF	Jebel Ali (United Arab Emirites)

Table 1. Air Terminal Identifier Codes (Defense Transportation Regulation, 2008)

These four subsets were analyzed individually to avoid any variability arising directly from varying shipping times to the different POD geographic locations.

B. MATERIAL FLOW MAPPING

This study examined both the physical flow of material into and through the 5th Fleet area of operation as well as the numerical data provided by the NAVSUP Logistics Operations Center. The routes and methods used to move material through the region are necessarily dynamic due to the changing location of the requisitioning activity, and are therefore not standardized. Providing a visual material flow map helps readers to more easily understand a complex and highly variable supply distribution system. Interviews were conducted with experts from NAVSUP, CTF-53, and the NAVSUP Logistics Operation Center to assist in mapping the material flow that illustrated commonly used transportation methods, material shipping routes, transportation hubs, forward logistics sites, and the limitations and capabilities associated with each level of the material flow. The material flow diagram was used to determine transportation options and visibility at

decision points at various stages in the supply chain. With the visual flow map, issues critical to this study such as limitations in material visibility and key decision points can be more easily recognized.

V. DATA ANALYSIS

A. PRELIMINARY DATA ANALYSIS

For the preliminary data analysis, the data were sorted three times into subsets, by segment of the supply chain, and by shipping priority. The first sorting was into four subsets based on POD location - BAH, FJR, JIB, and ZIF. Within each of these subsets, the data were sorted again by segment of the supply chain – shipping origin location to POD and POD to the location of material requisitioning activity.

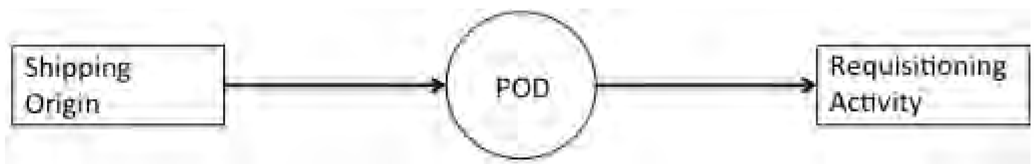

Figure 15. Two Segment Supply Chain Division

The final sort criterion for the data was shipping priority. The shipping priority was defined by the RDD in three categories - 999 for the highest priority material requisitions, 777 for material to be expedited but not meeting 999 criteria, and Other for any material requisitions not meeting criteria required for 999 or 777 RDDs.

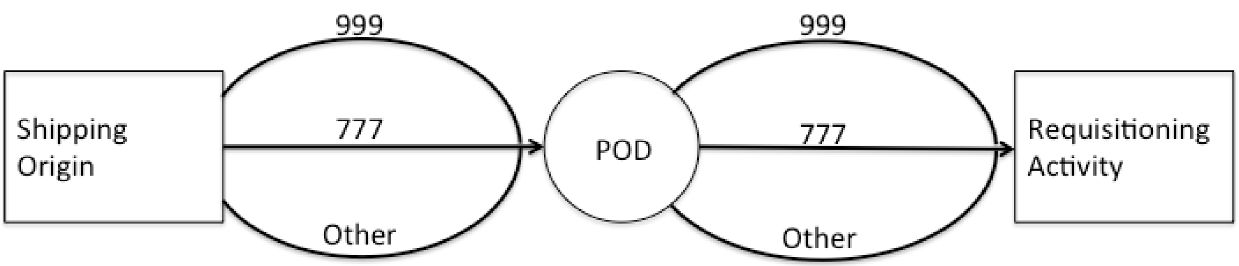

Figure 16. Shipping Priority Within Supply Chain Segment

After sorting the data, Microsoft Excel was used to produce the preliminary statistics of mean, standard deviation, sample variance, and count for the 24 possible iterations encompassed by the scope of this study. For each port of debarkation (POD) and supply chain segment, the mean and standard deviations of each shipping priority were compared to determine the general relationships of the material shipping times of

each shipping priority. This comparison was done for both segments of the supply chain, shipping time from origin to POD and shipping time from POD to the requisitioning activity. The expectation was that material requisitions with higher priority would ship faster and with lower variability than requisitions with lower priority for both segments of the supply chain within the scope of this study. In addition to the preliminary statistics, the data were used to build a histogram for each POD location depicting the number of requisitions and shipping times in days. To build the histograms, bins of one day were used for shipping times, and the number of requisitions counted for each shipping time, from 1–200 days. To make a visual comparison of the data in each POD histogram, the data were normalized and the histograms presented as the percentage of each type of requisition in each segment of the supply chain for each POD.

The descriptive statistics for Bahrain show mean shipping times from shipping to POD as within 2.5 days of each other, with the 999 priority shipping being the fastest with a mean and standard deviation of 4.6 and 4.2 days respectively, the 777 priority with the second fastest with mean and standard deviation of 6.4 and 7.3 days, and the Other with the slowest transit mean and standard deviation of 6.9 and 10.7 days. These results follow the expected trends for both the mean and standard deviation. From POD to receipt, the 999 priority had the fastest mean of 7.2 days, the Other priority was second with a mean of 8.3 days, and the 777 priority was slowest with a mean of 10.8 days. The standard deviations for the three priorities were similar and ranged from 14.2 to 15.4 days. While the standard deviations were similar to what was expected, the mean transit times did not follow the expected trend with the 777 priority shipping more slowly than the regular priority. The preliminary statistics for material requisitions with a POD of Bahrain are found in Table 2, and the histograms for Bahrain are found in Figure 17.

	Bahrain	Ship to POD	POD to Received
999	Mean	4.62	7.24
	Standard Deviation	4.17	14.24
777	Mean	6.43	10.80
	Standard Deviation	7.29	15.38
Other	Mean	6.94	8.33
	Standard Deviation	10.75	14.53

Table 2. Summary Descriptive Statistics Bahrain

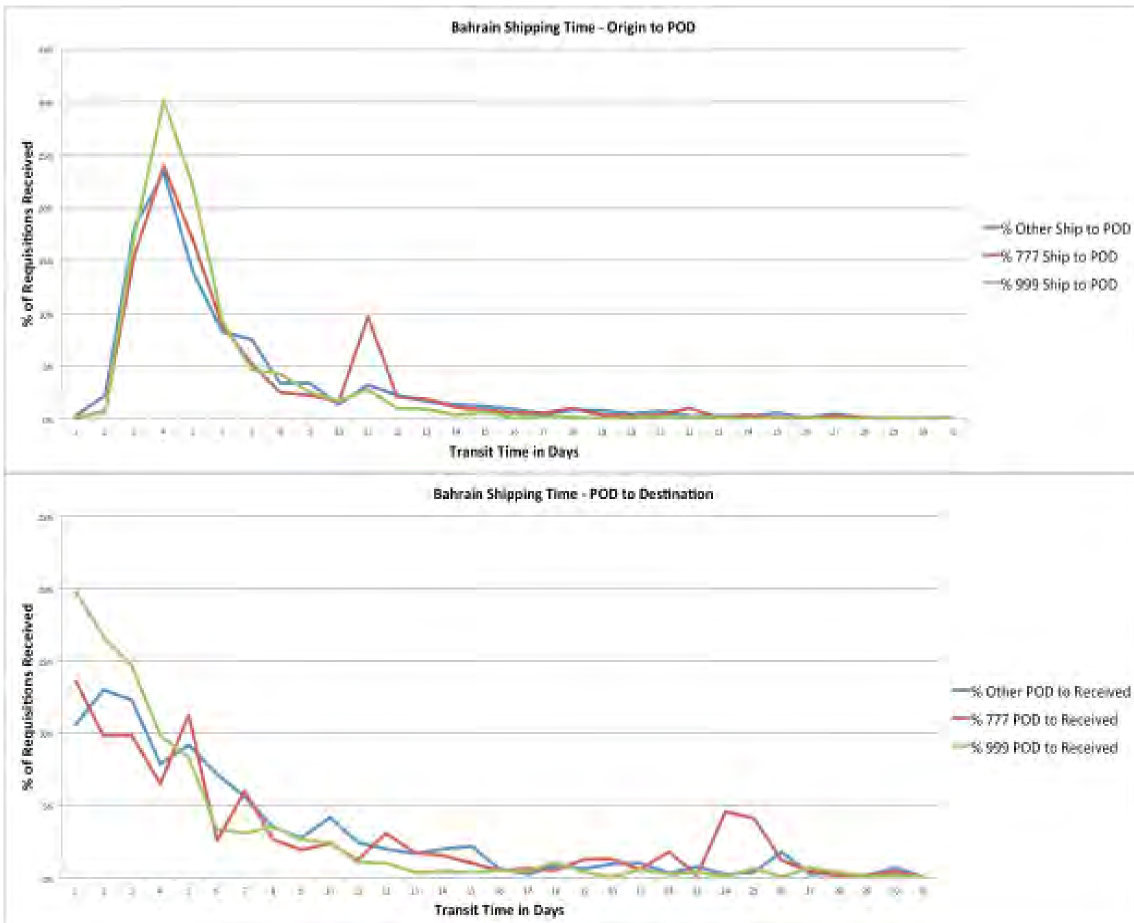

Figure 17. POD Bahrain Shipping Times

The descriptive statistics for Fujairah show mean shipping times from shipping to POD with the 999 priority shipping as the fastest with a mean and standard deviation of 9.2 and 8.9 days, the 777 priority with the second fastest with mean and standard deviation of 12.9 and 13.8 days, and the Other with the slowest transit mean and greatest

standard deviation of 29.4 and 31.6 days. Both the mean and standard deviation for transit times from shipping to POD followed the expected trends for each priority. From POD to receipt, the 777 and Other priorities had similar means of 8.8 days and standard deviations of 11.2 days for 777 and 12.8 for Other. The 999 priority had the slowest mean transit time of 13.8 days and greatest standard deviation of 16.8 days. These findings are unexpected as the highest priority material was shipped with the slowest mean time and had the greatest variability. The preliminary statistics for material requisitions with a POD of Fujairah are found in Table 3, and the histograms for Fujairah are found in Figure 18.

	Fujairah	Ship to POD	POD to Received
999	Mean	9.20	13.78
	Standard Deviation	8.89	16.77
777	Mean	12.89	8.79
	Standard Deviation	13.81	11.25
Other	Mean	29.37	8.85
	Standard Deviation	31.64	12.80

Table 3. Summary Descriptive Statistics Fujairah

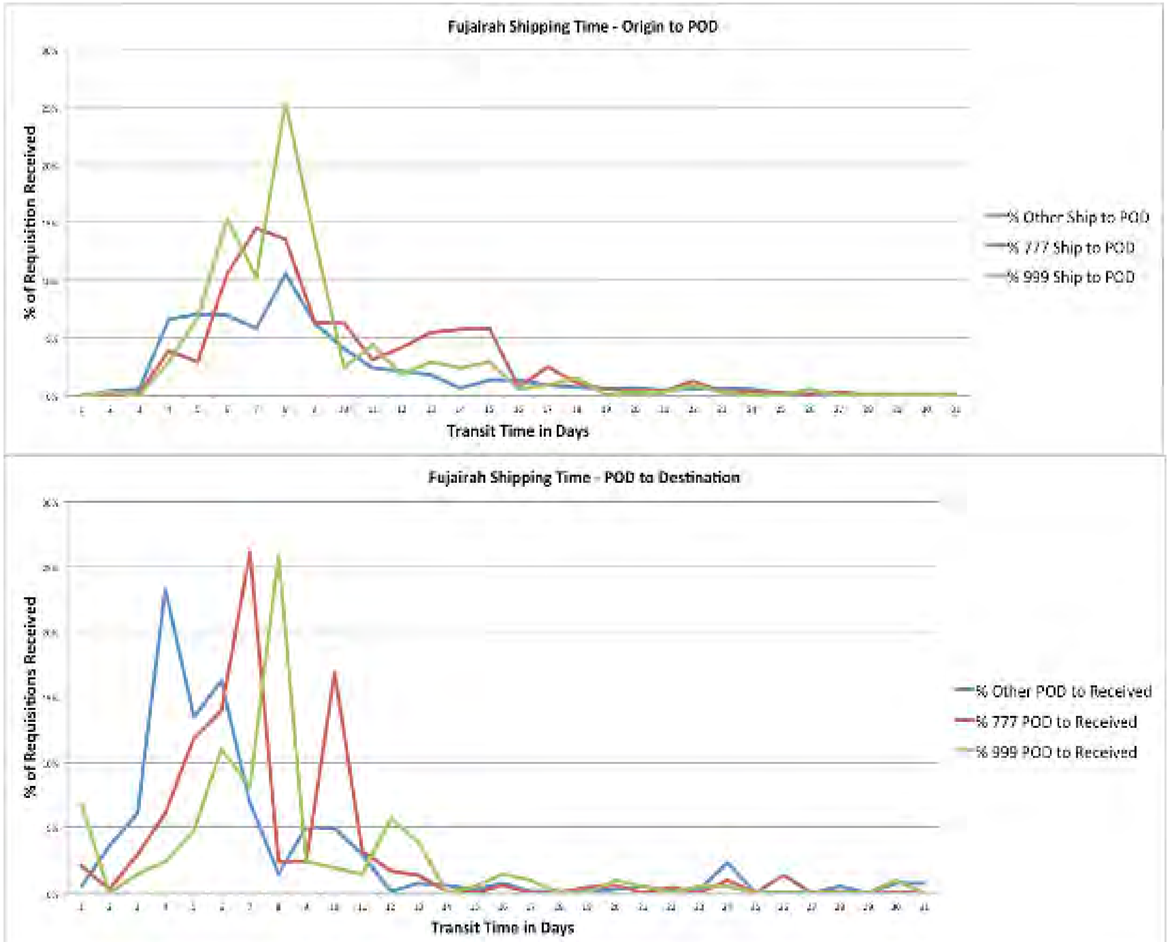

Figure 18. Fujairah Shipping Times

The descriptive statistics for Djibouti show that priority 999 material had the fastest mean transit time and smallest standard deviation from ship to POD of 6.8 and 4.1 days. Priority 777 material was second with mean and standard deviation of 7.6 and 4.8 days, and Other material was the slowest with the greatest standard deviation of 9.8 and 10.2 days. The mean and standard deviation trends for requisitions moving from shipping to POD followed expectations for all priorities. Shipping transit times from POD to receipt followed expected trends with the 999 priority as the fastest with mean and standard deviation of 8.1 and 11.6 days. The 777 priority was second with mean and standard deviation of 9.4 and 14.2 days. The Other priority was slowest with a mean and

standard deviation of 9.5 and 13.1 days. The descriptive statistics for material requisitions with a POD of Djibouti are found in Table 4, and the histograms are found in Figure 19.

	Djibouti	Ship to POD	POD to Received
999	Mean	6.77	8.09
	Standard Deviation	4.06	11.58
777	Mean	7.60	9.43
	Standard Deviation	4.82	14.17
Other	Mean	9.83	9.48
	Standard Deviation	10.23	13.08

Table 4. Summary Descriptive Statistics Djibouti

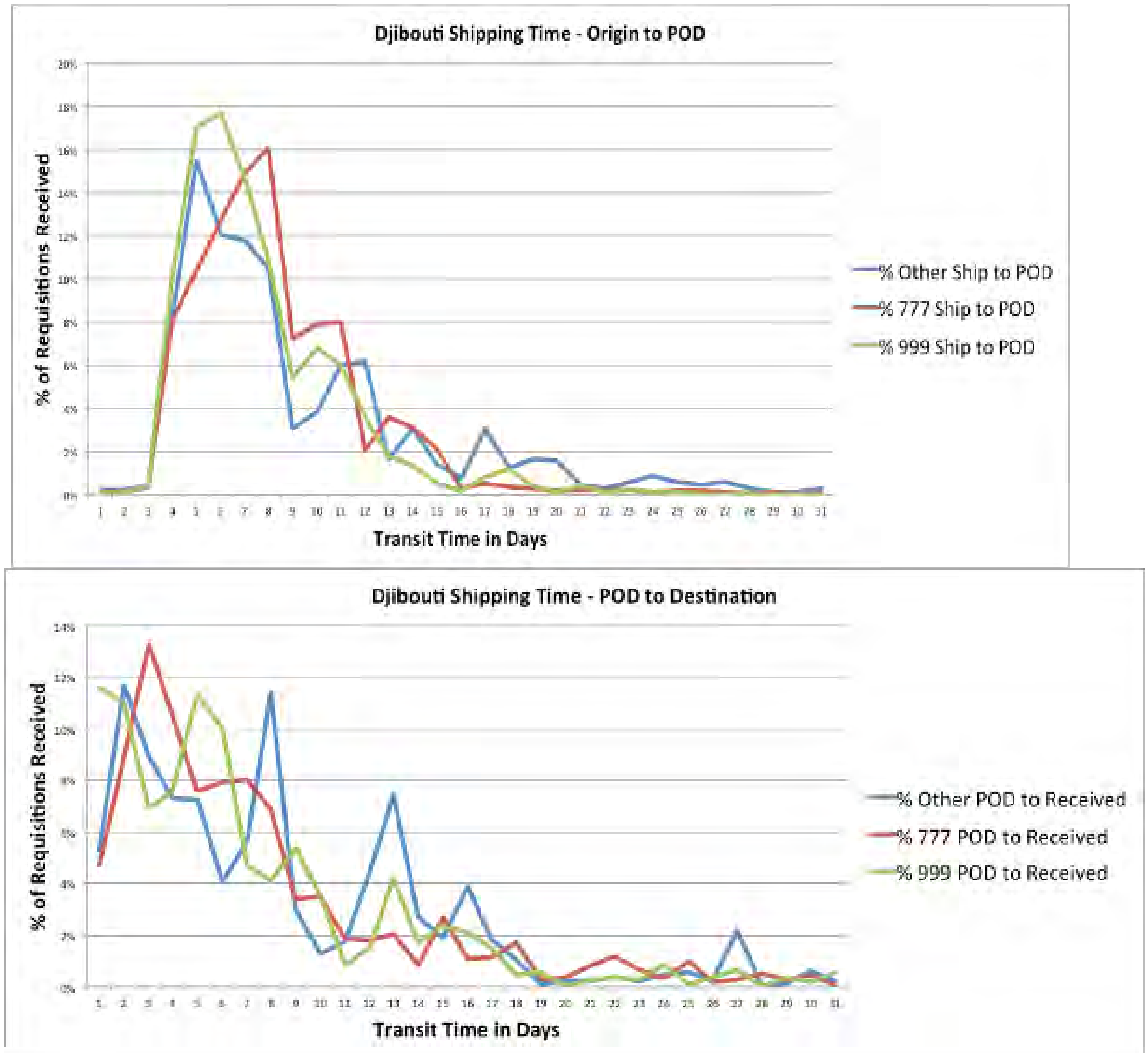

Figure 19. Djibouti Shipping Times

The descriptive statistics for Jebel Ali showed that from ship to POD, items with 999 priority have the fastest transit time and smallest standard deviation, 10.2 and 12.7 days respectively. The 777 priority was second in both mean and standard deviation with 12.9 and 16.6 days. Items with Other priority had the slowest transit time mean and greatest standard deviation of 29.3 and 26.8 days. Material requisitions shipped from POD to receipt did not follow expected behavior as the other priority had the fastest mean transit time of 8.7 with a standard deviation of 12.6 days. The 777 priority was second

fastest with a mean of 7.8 and a standard deviation of 10.7 days. The highest priority 999 material was the slowest with a mean of 9.9 and a standard deviation of 13 days. The descriptive statistics for material requisitions with a POD of Jebel Ali are found in Table 5, and the histograms for Jebel Ali are found in Figure 20.

	Jebel Ali	Ship to POD	POD to Received
999	Mean	10.18	9.91
	Standard Deviation	12.75	12.96
777	Mean	12.93	7.84
	Standard Deviation	16.64	10.72
Other	Mean	29.34	8.69
	Standard Deviation	26.88	12.62

Table 5. Summary Descriptive Statistics Jebel Ali

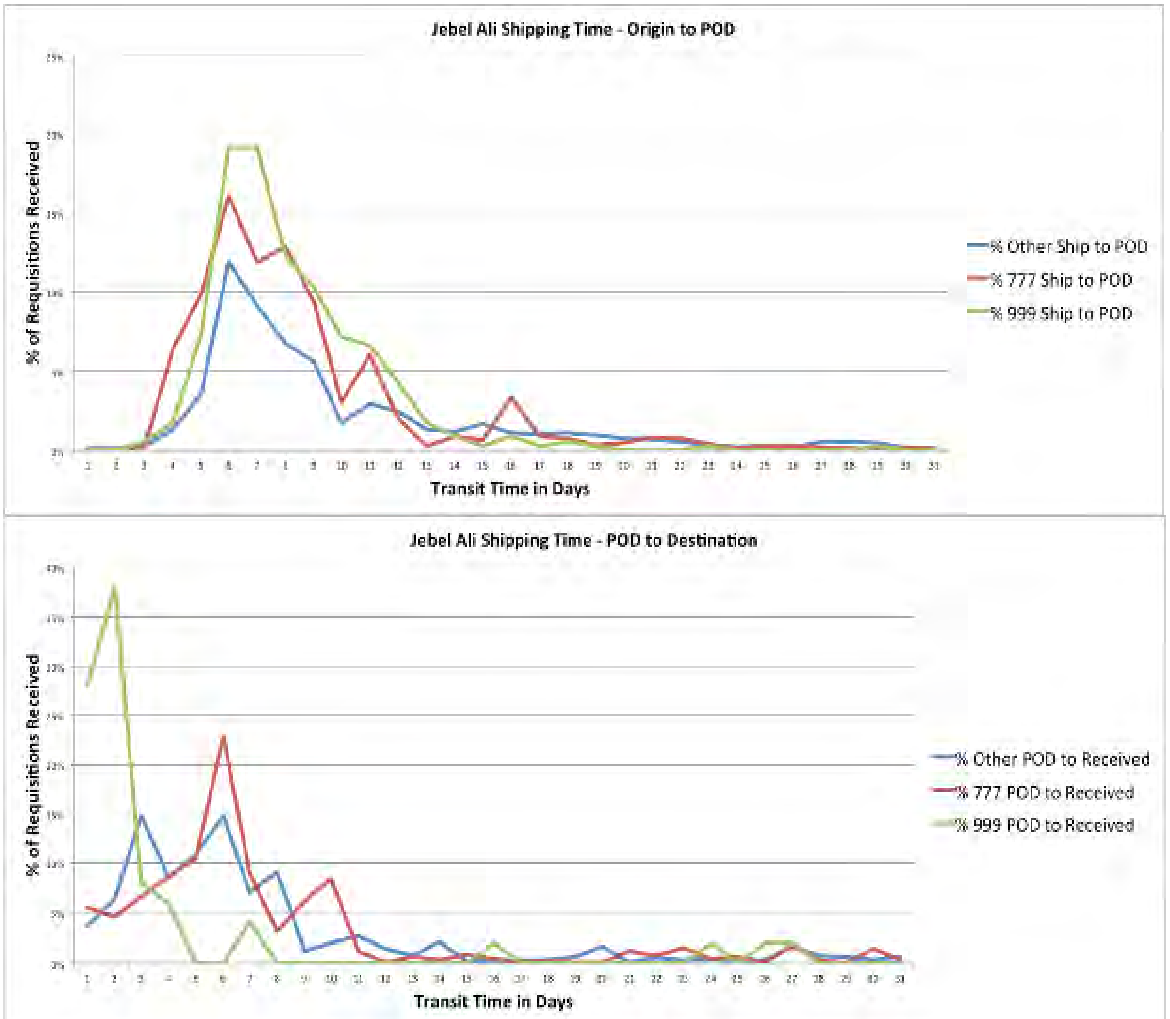

Figure 20. Jebel Ali Shipping Times

B. T-STATISTIC ANALYSIS

While a cursory comparison between the means of a given POD and segment of the supply chain gives some impression of the relationship of shipping times and priority, legitimate comparisons can only be made when statistical significance is established. Each of the three priorities were compared with one another: Other – 777, Other – 999, and 777 -999. Once these relationships were established for each of the two segments of the supply chain, the segments were then compared to one another. For instance, the "Other – 777" test statistic from the "Ship to POD" segment of the supply chain was compared to the "Other – 777" test statistic from the "POD to Received" segment of the

supply chain. The comparison between these statistics demonstrates the variability in supply chain performance and variability between the two segments, the first segment, Ship to POD, where visibility exists, and the second, POD to received, where visibility is not present. To compare each of the three priorities across the two segments of the supply chain for each of the four PODs, 24 t-tests had to be conducted; six for each of the four PODs. The t-statistic measures the difference between two sample means by using the sample mean x the sample variance s^2, and the sample size n. To compare the population means of two given priorities along a segment of the supply chain, the two means are first assumed to be equal, meaning that the null hypothesis is

$$H_0: \mu_1 - \mu_2 = 0$$

Significant deviation from the null hypothesis would suggest that the alternative hypothesis were true, or

$$H_1: \mu_1 - \mu_2 \neq 0$$

If the alternative hypothesis is correct, then it can be concluded two compared priority shipments have different means.

Before the test statistic was calculated, the rejection region had to be determined using a given confidence interval and the number of degrees of freedom of the test statistic. The confidence interval used for this study was 95%. This corresponds to $\alpha = 1 - .95$, or $\alpha = .05$ for each of the tests. The unequal sample variance t-test is best represented by the Student-t distribution. The Student-t distribution looks similar to the normal distribution, but differs in that the variance of a standard normal random variable is 1, and the variance of a Student-t random variable is given by $v/(v-2)$, where v is the number of degrees of freedom of the distribution and determines the distribution's dispersion. The greater the value of the number of degrees of freedom, the narrower the Student-t distribution becomes, and approaches the standard normal distribution. The number of degrees of freedom (v) is a function of the sample's variances s^2 and the sample size n. The following equation represents the number of degrees of freedom of the test statistic:

$$v = \frac{\left(\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}\right)^2}{\frac{\left(\frac{s_1^2}{n_1}\right)^2}{n_1 - 1} + \frac{\left(\frac{s_2^2}{n_2}\right)^2}{n_2 - 1}}$$

Once the confidence interval and the number of degrees of freedom were determined, the rejection region was defined using the t-distribution table, which assigns a t-value ($t_{(\alpha, v)}$) based on the confidence level and degree of freedom inputs. A t-statistic (t) falling below the negative t-value ($-t_{(\alpha, v)}$) or above the positive t-value ($t_{(\alpha, v)}$) falls in the rejection region. When the t-statistic falls within the rejection region, it can be concluded that the two means being compared are different. The rejection region is given by

$$t < -t_{\alpha,v} \text{ or } t > t_{\alpha,v}$$

For each of the 24 t-tests, results varied for the number of degrees of freedom, v, but each value of the rejection region fell between $|-t_{\alpha,v}| = 1.96$ and $|-t_{\alpha,v}| = 1.97$. To determine the test statistic, the previously calculated descriptive statistics of the sample mean $\bar{x}$, the sample variance s^2, and the sample size n was used. The value of the test statistic, assuming unequal variances, is given by

$$t = \frac{(\bar{x}_1 - \bar{x}_2) - (\mu_1 - \mu_2)}{\sqrt{\left(\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}\right)}}$$

The sample variances given by the descriptive statistics provided sufficient evidence to assume unequal population variances. If the value of the test statistic fell outside the rejection region, it could be said that with 95% confidence, the alternative hypothesis was correct, and the means of the two distributions were not equal. For this study, unequal means between two given shipping priorities translates to one of those priorities shipping faster than the other, on average.

C. T-TEST ANALYSIS RESULTS

After performing the t-test on each priority combination at each segment and POD, the tests of corresponding segment pairs were compared to determine the degree of transit time similarity based upon a requisition's priority. For instance, a t-stat of 5.0 between priority 777 and 999 from point of origin to POD would suggest that the time to ship material to that particular POD is statistically faster for materials with high priority. However, if the t-statistic comparing the shipping time from the POD to the destination is 1.0, it would suggest that the time to ship from the POD to the destination is not statistically different, whether it is shipped with high priority or not.

All of the test statistic values for Bahrain fell in the rejection region, suggesting that the mean shipping times between the different priorities were statistically different in all cases except one. Notably, it was shown that in one instance, from the POD to the destination, the 777 priority shipped slower on average than the Other priority. The values for the Other – 777 priority test statistics were 2.54 coming in to the POD, and -6.37 going out of the POD. This means that priority 777 material shipped faster to the POD, and the priority Other material shipped faster from the POD. The values for the Other – 999 priority test statistics were 11.94 coming into the POD, and 2.40 going out of the POD. This means that priority 999 material shipped faster in both segments of the supply chain, and the difference in shipping speeds was more pronounced going into the POD. The values for the 777 – 999 priority test statistics were 14.42 coming into the POD, and 8.74 going out of the POD. This means that priority 999 material shipped faster in both segments of the supply chain, and the difference in shipping speeds was more pronounced going into the POD. Generally, the variability of the means coming in to the POD was much greater than the variability going out of the POD. The test statistic values for Bahrain are given in Table 6.

Bahrain T-Statistics		
Priority Comparison	Ship to POD	POD to Received
Other - 777	2.54	-6.37
Other – 999	11.94	2.40
777 - 999	14.42	8.74

Table 6. Bahrain Test Statistics

All but one of the test statistic values for Fujairah fell within the rejection region, suggesting that the mean shipping times between the different priorities were statistically different in all cases except one. Two of the priority comparisons, both from the POD to the destination, showed that both the 777 and Other priorities shipped faster than the highest 999 priority. The values for the Other – 777 test statistics were 17.35 coming into the POD, and 0.11 going out of the POD. This means the priority 777 material shipped faster coming into the POD, but both priorities shipped with the same speed going out of the POD. The values for the Other – 999 test statistics were 20.62 coming into the POD, and -3.96 going out of the POD. This means the priority 999 material came into the POD faster, but went out slower than the lower priority Other. The values for the 777 – 999 test statistics were 5.74 coming into the POD, and -4.05 going out of the POD. This means the priority 999 material came into the POD faster, but went out slower than the lower priority 777. The test statistic values for Fujairah are given in Table 7.

Fujairah T-Statistics		
Priority Comparison	Ship to POD	POD to Received
Other - 777	17.35	0.11
Other - 999	20.62	-3.96
777 - 999	5.74	-4.05

Table 7. Fujairah Test Statistics

All but one of the test statistic values for Djibouti fell within the rejection region, suggesting that the mean shipping times between the different priorities were statistically different in all cases except one. In all comparisons, the higher priority was shipped faster than the lower priority. The values for the Other – 777 test statistics were 11.12 coming into the POD, and 0.13 going out of the POD. This means the priority 777 material shipped faster coming into the POD, but both priorities shipped with the same speed going out of the POD. The values for the Other – 999 test statistics were 14.54 coming into the POD, and 2.80 going out of the POD. This means the priority 999 material came into and went out of the POD faster. The values for the 777 – 999 test statistics were 8.77 coming into the POD, and 3.20 going out of the POD. This means the priority 999 material came into and went out of the POD faster. The variability of the

means coming in to the POD was much greater than the variability going out of the POD. The test statistic values for Djibouti are given in Table 8

Djibouti T-Statistics		
Priority Comparison	Ship to POD	POD to Received
Other - 777	11.12	0.13
Other - 999	14.54	2.80
777 - 999	8.77	3.20

Table 8. Djibouti Test Statistics

All but two of the test statistic values for Jebel Ali fell within the rejection region, suggesting that the mean shipping times between the different priorities were statistically different in all cases except two. As with Fujairah, the highest 999 priority was determined to be the slowest of the three priorities from the POD to the destination. The values for the Other – 777 test statistics were 23.50 coming into the POD, and 1.65 going out of the POD. This means the priority 777 material shipped faster coming into the POD, but both priorities shipped with the same speed going out of the POD. The values for the Other – 999 test statistics were 22.29 coming into the POD, and -1.26 going out of the POD. This means the priority 999 material came into the POD faster, but went out slower than the lower priority Other. The values for the 777 – 999 test statistics were 3.34 coming into the POD, and -2.15 going out of the POD. This means the priority 999 material came into the POD faster, but went out slower than the lower priority 777. Generally, the variability of the means coming in to the POD was much greater than the variability going out of the POD. The test statistic values for Jebel Ali are given in Table 9.

Jebel Ali T-Statistics		
Priority Comparison	Ship to POD	POD to Received
Other - 777	23.50	1.65
Other - 999	22.29	-1.26
777 - 999	3.34	-2.15

Table 9. Jebel Ali Test Statistics

VI. CONCLUSIONS

A. SUPPLY CHAIN FROM ORIGIN TO POD

As would be expected in a properly functioning supply chain, material flowing into all Fifth Fleet PODs, on average, arrives faster if it is ordered with the highest shipping priority, 999. The next lower shipping priority, 777, arrives on average, the second fastest. Finally, material with an RDD other than 999 or 777, arrives, on average slowest. Where significant, the t-tests show that with 95% confidence we can say the differences in shipping time between priorities are statistically significant, meaning it is unlikely that we are observing performance differences resulting from chance. We see the supply chain up to the PODs is functioning correctly with regards to shipping priorities.

Mean Shipping Times to POD			
POD	999	777	Other
Bahrain (BAH)	4.62	6.43	6.94
Fujairah (FJR)	9.20	12.89	29.37
Djibouti (JIB)	6.77	7.60	9.83
Jebel Ali (ZJF)	10.18	12.93	29.34

Table 10. Mean Shipping Times to POD

B. SUPPLY CHAIN FROM POD TO END USER

Material shipping from the PODs to the end user does not follow what would be expected in a properly functioning supply chain. The departure from expected results indicates there is a breakdown in the supply system at some point after arrival at the POD. Only in Djibouti do the average shipping times follow the expected result, but even then, 777 and Other are statistically indistinguishable.

The fact that every POD produced different results may indicate a difference in the material handling processes used at each location. It may also indicate that peculiarities in each location (geographic position, manning, etc.) affect the materials' shipping times.

The breakdown of how assigned priorities ship could be caused by a variety of reasons. Material routing by CTF-53 may not consider the RDDs. The material handling processes at the PODs may not consider the RDDs. There may be other reasons that account for these results that remain hidden because the lack of visibility causes a lack of analyzable data.

Mean Shipping Times from POD to End User			
POD	999	777	Other
Bahrain (BAH)	7.24	10.80	8.33
Fujairah (FJR)	13.78	8.79	8.85
Djibouti (JIB)	8.09	9.43	9.48
Jebel Ali (ZJF)	9.91	7.84	8.69

Table 11. Mean Shipping Times from POD to End User

C. LIMITATIONS

There are several factors that may affect the conclusions of this study. The effect they may have on the study's results bear mentioning.

The backorder of material would increase the time it takes for an item to arrive at the POD. If a particular priority tended to be backordered more frequently the results would be skewed. This was accounted for by calculating origin to POD by the date shipped from origin not the date ordered. By using only the in-transit time, the effect of backorders was effectively removed.

Items ordered under a particular priority may be inherently more difficult to ship due to bulk, weight, origination, etc. However, the priority is assigned based on the criticality of its effect to mission readiness. An item ordered with an RDD of 999 may be subsequently ordered under an RDD of 777 or Other based on how that particular item affects the mission at that time. If certain items were inherently more difficult to ship we would expect to see those effects on material shipping to the POD as well as out of the POD, which we did not.

Because 26% of the original data was discarded due to illogical shipping dates or missing data, it can be assumed that some of the data used for analysis was also

corrupted. The discarded data was found to be evenly distributed between supply chain segments, PODs and priorities, so there is no reason to suspect that any other corrupted data would skew this study's results.

Although material is assigned a priority by the requisitioning activity, decisions made by CTF-53 have a great effect of the speed of delivery. It can be assumed units performing critical missions would have an implicitly high priority on their material than units preparing to depart the AOR. While this study did not look at individual units, nor their taskings, given the volume of data analyzed, we believe that any preference given to units based on their tasking would be outliers and not affect our analysis.

As the same data were used in multiple comparisons (for example, the 777 shipping times from Bahrain were compared to both the 999 and Other shipping times in two separate comparisons), the t-tests should have been multiple-comparison protected (Hochberg & Tamhane, 1987). However, given the magnitude of differences observed, and the resulting large t-statistic, it is unlikely a multiple comparison correction would have changed a significant t-test result to one of no significance.

Finally, this study assumed that the reported date received was the same as physical receipt onboard. Unit personnel manually input material receipts and there is no way to know if this assumption is correct.

D. RECOMMENDATIONS

1. For Further Study

An effective cost-benefit analysis cannot be preformed until more light is shed on why the assigned RDD priorities breakdown post-POD arrival. However, we do not believe there is any evidence that full-scale implementation of initiatives to increase visibility past the PODs would be cost effective. This is due to the lack of shipping options once a final POD is decided upon. Once material departs the POD, the final mode of delivery (UNREP ship, COD, etc.) has been determined. This causes delivery time to be largely inflexible.

Further study into the issues presented is warranted to uncover their root causes. We propose the following:

a. POD Processes

To fully understand why material ships differently than expected from the PODs, an operations management analysis of the material handling processes at each POD should be conducted. Further study should include comparisons of material handling processes at each POD, specifically as they apply to the various shipping priorities of material. This should lead to uncovering best practices, which could be applied to the other PODs. By also analyzing and comparing each POD’s workload, manpower and resources process improvements may present themselves.

b. Earlier Material Routing

Roughly half of the transit time from origin to end-user occurs prior to arrival at the POD. Due the decrease in shipping options as material flows further down the supply chain, relevant decisions should be made as early as possible to ensure the most expeditious and efficient system. We recommend a study to investigate pushing material routing decisions earlier than is currently done.

Another possibility would be to use commercially available material routing software. This software is used by civilian sector businesses to optimize the efficiency of their supply chains.

2. Increased/Improved Visibility

At some point between arrival at the POD and receipt by the end user, the assigned RDD ceases to be an effective predictor of performance. If POD processes are found to be sufficient and earlier routing either infeasible or ineffective, the only way to diagnose problems will be through a clear understanding of what occurs after material leaves the POD. This will necessitate expanding in-transit visibility into the last nautical mile.

Additionally, there is a need for improved reliability in the visibility data. Nearly 30% of the raw data received for this study had to be discarded. In some cases, material was reported to be received before it was shipped, both from origin and POD. In other cases data was simply not reported. Data was discarded less often between the origin and POD than between the POD and end user. This is more than likely the result of automated tracking prior to the last nautical mile.

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX A

BAH Other Ship to POD	
Mean	6.937085
Standard Error	0.17507
Median	4
Mode	3
Standard Deviation	10.74506
Sample Variance	115.4562
Kurtosis	56.86996
Skewness	6.483486
Range	149
Minimum	0
Maximum	149
Sum	26132
Count	3767

BAH 777 Ship to POD	
Mean	6.432878
Standard Error	0.094066
Median	4
Mode	3
Standard Deviation	7.288742
Sample Variance	53.12576
Kurtosis	64.05407
Skewness	5.987961
Range	142
Minimum	0
Maximum	142
Sum	38623
Count	6004

BAH 999 Ship to POD	
Mean	4.624604
Standard Error	0.082919
Median	4
Mode	3
Standard Deviation	4.169098
Sample Variance	17.38138
Kurtosis	149.8229
Skewness	8.595523
Range	104
Minimum	0
Maximum	104
Sum	11691
Count	2528

BAH Other POD to Received	
Mean	8.326679
Standard Error	0.30944
Median	4
Mode	1
Standard Deviation	14.52721
Sample Variance	211.0399
Kurtosis	81.65411
Skewness	6.794846
Range	280
Minimum	0
Maximum	280
Sum	18352
Count	2204

BAH 777 POD to Received	
Mean	10.8044
Standard Error	0.235394
Median	4
Mode	0
Standard Deviation	15.38008
Sample Variance	236.5468
Kurtosis	14.4749
Skewness	3.141583
Range	147
Minimum	0
Maximum	147
Sum	46124
Count	4269

BAH 999 POD to Received	
Mean	7.23726
Standard Error	0.333264
Median	2
Mode	0
Standard Deviation	14.23703
Sample Variance	202.6931
Kurtosis	18.00203
Skewness	3.842192
Range	126
Minimum	0
Maximum	126
Sum	13208
Count	1825

Table 12. Bahrain Descriptive Statistics

FJR Other Ship to POD	
Mean	29.36994
Standard Error	0.850522
Median	10
Mode	7
Standard Deviation	31.64125
Sample Variance	1001.169
Kurtosis	0.51676
Skewness	1.201545
Range	136
Minimum	1
Maximum	137
Sum	40648
Count	1384

FJR 777 Ship to POD	
Mean	12.88837
Standard Error	0.423022
Median	8
Mode	6
Standard Deviation	13.81153
Sample Variance	190.7584
Kurtosis	13.01489
Skewness	3.284609
Range	119
Minimum	2
Maximum	121
Sum	13739
Count	1066

FJR 999 Ship to POD	
Mean	9.20059
Standard Error	0.483033
Median	7
Mode	7
Standard Deviation	8.893579
Sample Variance	79.09574
Kurtosis	25.96542
Skewness	4.686871
Range	75
Minimum	1
Maximum	76
Sum	3119
Count	339

FJR Other POD to Received	
Mean	8.853988
Standard Error	0.448307
Median	5
Mode	3
Standard Deviation	12.79836
Sample Variance	163.7981
Kurtosis	35.3107
Skewness	4.718671
Range	157
Minimum	0
Maximum	157
Sum	7216
Count	815

FJR 777 POD to Received	
Mean	8.788966
Standard Error	0.41785
Median	6
Mode	6
Standard Deviation	11.25095
Sample Variance	126.5839
Kurtosis	36.93034
Skewness	5.375088
Range	124
Minimum	0
Maximum	124
Sum	6372
Count	725

FJR 999 POD to Received	
Mean	13.78469
Standard Error	1.160093
Median	7
Mode	7
Standard Deviation	16.77127
Sample Variance	281.2755
Kurtosis	15.02341
Skewness	3.164314
Range	135
Minimum	0
Maximum	135
Sum	2881
Count	209

Table 13. Fujairah Descriptive Statistics

JIB Other Ship to POD	
Mean	9.82991
Standard Error	0.194155
Median	7
Mode	4
Standard Deviation	10.22775
Sample Variance	104.607
Kurtosis	35.35066
Skewness	4.755258
Range	140
Minimum	0
Maximum	140
Sum	27278
Count	2775

JIB 777 Ship to POD	
Mean	7.603135
Standard Error	0.049319
Median	7
Mode	7
Standard Deviation	4.824658
Sample Variance	23.27732
Kurtosis	91.86335
Skewness	6.274052
Range	118
Minimum	0
Maximum	118
Sum	72762
Count	9570

JIB 999 Ship to POD	
Mean	6.768332
Standard Error	0.081478
Median	6
Mode	5
Standard Deviation	4.059205
Sample Variance	16.47714
Kurtosis	62.52819
Skewness	5.177068
Range	79
Minimum	0
Maximum	79
Sum	16799
Count	2482

JIB Other POD to Received	
Mean	9.481254
Standard Error	0.341426
Median	6
Mode	1
Standard Deviation	13.07712
Sample Variance	171.0111
Kurtosis	23.35584
Skewness	4.205104
Range	123
Minimum	0
Maximum	123
Sum	13909
Count	1467

JIB 777 POD to Received	
Mean	9.428121
Standard Error	0.212575
Median	5
Mode	2
Standard Deviation	14.17253
Sample Variance	200.8606
Kurtosis	19.02185
Skewness	3.883306
Range	132
Minimum	0
Maximum	132
Sum	41908
Count	4445

JIB 999 POD to Received	
Mean	8.09387
Standard Error	0.358515
Median	5
Mode	0
Standard Deviation	11.58398
Sample Variance	134.1887
Kurtosis	17.51359
Skewness	3.65866
Range	105
Minimum	0
Maximum	105
Sum	8450
Count	1044

Table 14. Djibouti Descriptive Statistics

ZJF Other Ship to POD	
Mean	29.33968
Standard Error	0.524511
Median	15
Mode	5
Standard Deviation	26.87829
Sample Variance	722.4423
Kurtosis	-0.33588
Skewness	0.831449
Range	151
Minimum	0
Maximum	151
Sum	77046
Count	2626

ZJF 777 Ship to POD	
Mean	12.92544
Standard Error	0.461306
Median	7
Mode	5
Standard Deviation	16.63901
Sample Variance	276.8567
Kurtosis	9.141129
Skewness	2.943073
Range	122
Minimum	0
Maximum	122
Sum	16816
Count	1301

ZJF 999 Ship to POD	
Mean	10.17714
Standard Error	0.681388
Median	7
Mode	5
Standard Deviation	12.74761
Sample Variance	162.5015
Kurtosis	15.71236
Skewness	3.927547
Range	87
Minimum	2
Maximum	89
Sum	3562
Count	350

ZJF Other POD to Received	
Mean	8.688983
Standard Error	0.367269
Median	5
Mode	5
Standard Deviation	12.61611
Sample Variance	159.1661
Kurtosis	26.48303
Skewness	4.204417
Range	151
Minimum	0
Maximum	151
Sum	10253
Count	1180

ZJF 777 POD to Received	
Mean	7.835088
Standard Error	0.366462
Median	5
Mode	5
Standard Deviation	10.71549
Sample Variance	114.8217
Kurtosis	49.10168
Skewness	5.732497
Range	129
Minimum	0
Maximum	129
Sum	6699
Count	855

ZJF 999 POD to Received	
Mean	9.909524
Standard Error	0.893985
Median	5
Mode	5
Standard Deviation	12.95507
Sample Variance	167.8339
Kurtosis	4.443417
Skewness	2.119908
Range	78
Minimum	0
Maximum	78
Sum	2081
Count	210

Table 15. Jebel Ali Descriptive Statistics

t-Test: Two-Sample Assuming Unequal Variances	BAH Other Ship to POD	BAH 777 Ship to POD
Mean	6.937085214	6.432878081
Variance	115.4562106	53.1257621
Observations	3767	6004
Hypothesized Mean Difference	0	
df	5944	
t Stat	2.537012903	
P(T<=t) one-tail	0.005602818	
t Critical one-tail	1.645110021	
P(T<=t) two-tail	0.011205636	
t Critical two-tail	1.960363168	

Table 16. T-Test Results Other – 777 Ship to POD Bahrain

t-Test: Two-Sample Assuming Unequal Variances	BAH Other POD to Received	BAH 777 POD to Received
Mean	8.326678766	10.80440384
Variance	211.0398508	236.5467847
Observations	2204	4269
Hypothesized Mean Difference	0	
df	4681	
t Stat	-6.372791449	
P(T<=t) one-tail	1.01738E-10	
t Critical one-tail	1.645179214	
P(T<=t) two-tail	2.03476E-10	
t Critical two-tail	1.960470901	

Table 17. T-Test Results Other – 777 POD to Received Bahrain

t-Test: Two-Sample Assuming Unequal Variances	BAH Other Ship to POD	BAH 999 Ship to POD
Mean	6.937085214	4.62460443
Variance	115.4562106	17.38138093
Observations	3767	2528
Hypothesized Mean Difference	0	
df	5251	
t Stat	11.93763276	
P(T<=t) one-tail	9.86815E-33	
t Critical one-tail	1.645143865	
P(T<=t) two-tail	1.97363E-32	
t Critical two-tail	1.960415862	

Table 18. T-Test Results Other – 999 Ship to POD Bahrain

t-Test: Two-Sample Assuming Unequal Variances	BAH Other POD to Received	BAH 999 POD to Received
Mean	8.326678766	7.237260274
Variance	211.0398508	202.6931285
Observations	2204	1825
Hypothesized Mean Difference	0	
df	3915	
t Stat	2.395525221	
P(T<=t) one-tail	0.008321631	
t Critical one-tail	1.645242933	
P(T<=t) two-tail	0.016643261	
t Critical two-tail	1.960570113	

Table 19. T-Test Results Other – 999 POD to Received Bahrain

t-Test: Two-Sample Assuming Unequal Variances	*BAH 777 Ship to POD*	*BAH 999 Ship to POD*
Mean	6.432878081	4.62460443
Variance	53.1257621	17.38138093
Observations	6004	2528
Hypothesized Mean Difference	0	
df	7787	
t Stat	14.42060401	
P(T<=t) one-tail	7.61042E-47	
t Critical one-tail	1.645049332	
P(T<=t) two-tail	1.52208E-46	
t Critical two-tail	1.960268676	

Table 20. T-Test Results 777 – 999 Ship to POD Bahrain

t-Test: Two-Sample Assuming Unequal Variances	*BAH 777 POD to Received*	*BAH 999 POD to Received*
Mean	10.80440384	7.237260274
Variance	236.5467847	202.6931285
Observations	4269	1825
Hypothesized Mean Difference	0	
df	3704	
t Stat	8.742708035	
P(T<=t) one-tail	1.69614E-18	
t Critical one-tail	1.645265115	
P(T<=t) two-tail	3.39228E-18	
t Critical two-tail	1.960604652	

Table 21. T-Test Results 777 – 999 POD to Received Bahrain

t-Test: Two-Sample Assuming Unequal Variances	*FJR Other Ship to POD*	*FJR 777 Ship to POD*
Mean	29.3699422	12.88836773
Variance	1001.168901	190.7584186
Observations	1384	1066
Hypothesized Mean Difference	0	
df	1993	
t Stat	17.35060426	
P(T<=t) one-tail	3.23702E-63	
t Critical one-tail	1.645618545	
P(T<=t) two-tail	6.47403E-63	
t Critical two-tail	1.961154997	

Table 22. T-Test Results Other – 777 Ship to POD Fujairah

t-Test: Two-Sample Assuming Unequal Variances	*FJR Other POD to Received*	*FJR 777 POD to Received*
Mean	8.85398773	8.788965517
Variance	163.7980645	126.583856
Observations	815	725
Hypothesized Mean Difference	0	
df	1538	
t Stat	0.106099144	
P(T<=t) one-tail	0.457758763	
t Critical one-tail	1.645844975	
P(T<=t) two-tail	0.915517527	
t Critical two-tail	1.961507617	

Table 23. T-Test Results Other – 777 POD to Received Fujairah

t-Test: Two-Sample Assuming Unequal Variances	*FJR Other Ship to POD*	*FJR 999 Ship to POD*
Mean	29.3699422	9.200589971
Variance	1001.168901	79.0957393
Observations	1384	339
Hypothesized Mean Difference	0	
df	1697	
t Stat	20.62063756	
P(T<=t) one-tail	8.69131E-85	
t Critical one-tail	1.64575204	
P(T<=t) two-tail	1.73826E-84	
t Critical two-tail	1.961362886	

Table 24. T-Test Results Other – 999 Ship to POD Fujairah

t-Test: Two-Sample Assuming Unequal Variances	*FJR Other POD to Received*	*FJR 999 POD to Received*
Mean	8.85398773	13.784689
Variance	163.7980645	281.2755337
Observations	815	209
Hypothesized Mean Difference	0	
df	273	
t Stat	-3.964535281	
P(T<=t) one-tail	4.69912E-05	
t Critical one-tail	1.650454303	
P(T<=t) two-tail	9.39824E-05	
t Critical two-tail	1.96869162	

Table 25. T-Test Results Other – 999 POD to Received Fujairah

t-Test: Two-Sample Assuming Unequal Variances	*FJR 777 Ship to POD*	*FJR 999 Ship to POD*
Mean	12.88836773	9.200589971
Variance	190.7584186	79.0957393
Observations	1066	339
Hypothesized Mean Difference	0	
df	889	
t Stat	5.743473195	
P(T<=t) one-tail	6.36526E-09	
t Critical one-tail	1.646569451	
P(T<=t) two-tail	1.27305E-08	
t Critical two-tail	1.962636031	

Table 26. T-Test Results 777 - 999 Ship to POD Fujairah

t-Test: Two-Sample Assuming Unequal Variances	*FJR 777 POD to Received*	*FJR 999 POD to Received*
Mean	8.788965517	13.784689
Variance	126.583856	281.2755337
Observations	725	209
Hypothesized Mean Difference	0	
df	264	
t Stat	-4.0515146	
P(T<=t) one-tail	3.34831E-05	
t Critical one-tail	1.65064591	
P(T<=t) two-tail	6.69663E-05	
t Critical two-tail	1.968990497	

Table 27. T-Test Results 777 - 999 POD to Received Fujairah

t-Test: Two-Sample Assuming Unequal Variances	*JIB Other Ship to POD*	*JIB 777 Ship to POD*
Mean	9.82990991	7.603134796
Variance	104.6069638	23.27732323
Observations	2775	9570
Hypothesized Mean Difference	0	
df	3140	
t Stat	11.11603125	
P(T<=t) one-tail	1.74707E-28	
t Critical one-tail	1.645339048	
P(T<=t) two-tail	3.49415E-28	
t Critical two-tail	1.960719771	

Table 28. T-Test Results Other – 777 Ship to POD Djibouti

t-Test: Two-Sample Assuming Unequal Variances	*JIB Other POD to Received*	*JIB 777 POD to Received*
Mean	9.48125426	9.428121485
Variance	171.011074	200.8605501
Observations	1467	4445
Hypothesized Mean Difference	0	
df	2690	
t Stat	0.13210736	
P(T<=t) one-tail	0.447454627	
t Critical one-tail	1.64542028	
P(T<=t) two-tail	0.894909255	
t Critical two-tail	1.96084626	

Table 29. T-Test Results Other – 777 POD to Received Djibouti

t-Test: Two-Sample Assuming Unequal Variances	*JIB Other Ship to POD*	*JIB 999 Ship to POD*
Mean	9.82990991	6.76833199
Variance	104.6069638	16.47714264
Observations	2775	2482
Hypothesized Mean Difference	0	
df	3708	
t Stat	14.54027611	
P(T<=t) one-tail	6.31279E-47	
t Critical one-tail	1.645264671	
P(T<=t) two-tail	1.26256E-46	
t Critical two-tail	1.960603961	

Table 30. T-Test Results Other – 999 Ship to POD Djibouti

t-Test: Two-Sample Assuming Unequal Variances	*JIB Other POD to Received*	*JIB 999 POD to Received*
Mean	9.48125426	8.093869732
Variance	171.011074	134.1886872
Observations	1467	1044
Hypothesized Mean Difference	0	
df	2393	
t Stat	2.802338494	
P(T<=t) one-tail	0.002557102	
t Critical one-tail	1.645490636	
P(T<=t) two-tail	0.005114203	
t Critical two-tail	1.960955815	

Table 31. T-Test Results Other – 999 POD to Received Djibouti

t-Test: Two-Sample Assuming Unequal Variances	*JIB 777 Ship to POD*	*JIB 999 Ship to POD*
Mean	7.603134796	6.76833199
Variance	23.27732323	16.47714264
Observations	9570	2482
Hypothesized Mean Difference	0	
df	4476	
t Stat	8.765099571	
P(T<=t) one-tail	1.30358E-18	
t Critical one-tail	1.645194129	
P(T<=t) two-tail	2.60716E-18	
t Critical two-tail	1.960494123	

Table 32. T-Test Results 777 - 999 Ship to POD Djibouti

t-Test: Two-Sample Assuming Unequal Variances	*JIB 777 POD to Received*	*JIB 999 POD to Received*
Mean	9.428121485	8.093869732
Variance	200.8605501	134.1886872
Observations	4445	1044
Hypothesized Mean Difference	0	
df	1852	
t Stat	3.201189406	
P(T<=t) one-tail	0.000695908	
t Critical one-tail	1.645676811	
P(T<=t) two-tail	0.001391815	
t Critical two-tail	1.961245732	

Table 33. T-Test Results 777 - 999 POD to Received Djibouti

t-Test: Two-Sample Assuming Unequal Variances	*ZJF Other Ship to POD*	*ZJF 777 Ship to POD*
Mean	29.33968012	12.92544197
Variance	722.4422877	276.8567445
Observations	2626	1301
Hypothesized Mean Difference	0	
df	3739	
t Stat	23.49897614	
P(T<=t) one-tail	2.624E-114	
t Critical one-tail	1.645261262	
P(T<=t) two-tail	5.248E-114	
t Critical two-tail	1.960598653	

Table 34. T-Test Results Other – 777 Ship to POD Jebel Ali

t-Test: Two-Sample Assuming Unequal Variances	*ZJF Other POD to Received*	*ZJF 777 POD to Received*
Mean	8.688983051	7.835087719
Variance	159.1661211	114.8217182
Observations	1180	855
Hypothesized Mean Difference	0	
df	1982	
t Stat	1.64582054	
P(T<=t) one-tail	0.049979632	
t Critical one-tail	1.645622792	
P(T<=t) two-tail	0.099959264	
t Critical two-tail	1.961161611	

Table 35. T-Test Results Other – 777 POD to Received Jebel Ali

t-Test: Two-Sample Assuming Unequal Variances	*ZJF Other Ship to POD*	*ZJF 999 Ship to POD*
Mean	29.33968012	10.17714286
Variance	722.4422877	162.5014818
Observations	2626	350
Hypothesized Mean Difference	0	
df	846	
t Stat	22.28501451	
P(T<=t) one-tail	3.20209E-87	
t Critical one-tail	1.646656758	
P(T<=t) two-tail	6.40418E-87	
t Critical two-tail	1.962772035	

Table 36. T-Test Results Other – 999 Ship to POD Jebel Ali

t-Test: Two-Sample Assuming Unequal Variances	*ZJF Other POD to Received*	*ZJF 999 POD to Received*
Mean	8.688983051	9.90952381
Variance	159.1661211	167.8338802
Observations	1180	210
Hypothesized Mean Difference	0	
df	284	
t Stat	-1.262864188	
P(T<=t) one-tail	0.103836932	
t Critical one-tail	1.650236662	
P(T<=t) two-tail	0.207673865	
t Critical two-tail	1.968352158	

Table 37. T-Test Results Other – 999 POD to Received Jebel Ali

t-Test: Two-Sample Assuming Unequal Variances	*ZJF 777 Ship to POD*	*ZJF 999 Ship to POD*
Mean	12.92544197	10.17714286
Variance	276.8567445	162.5014818
Observations	1301	350
Hypothesized Mean Difference	0	
df	703	
t Stat	3.33994905	
P(T<=t) one-tail	0.000441094	
t Critical one-tail	1.647024027	
P(T<=t) two-tail	0.000882187	
t Critical two-tail	1.9633442	

Table 38. T-Test Results 777 - 999 Ship to POD Jebel Ali

t-Test: Two-Sample Assuming Unequal Variances	*ZJF 777 POD to Received*	*ZJF 999 POD to Received*
Mean	7.835087719	9.90952381
Variance	114.8217182	167.8338802
Observations	855	210
Hypothesized Mean Difference	0	
df	283	
t Stat	-2.147049794	
P(T<=t) one-tail	0.01631946	
t Critical one-tail	1.650255746	
P(T<=t) two-tail	0.03263892	
t Critical two-tail	1.968381923	

Table 39. T-Test Results 777 - 999 POD to Received Jebel Ali

LIST OF REFERENCES

Banomyong, R., & Sopadang, A. (2010). Using monte carlo simulation to refine emergency logistics response models: A case study. International Journal of Physical Distribution & Logistics Management, 40(8), 709–721.

Boyer, K., Prud'homme, A., & Chung, W. (2009). The last mile challenge: Evaluating the effects of customer density and delivery window patterns. Journal of Business Logistics, 30(1), 185-IX. Retrieved from http://search.proquest.com/docview/212655475?accountid=12702

Caridi, M., Crippa, L., Perego, A., Sianesi, A., & Tumino, A. (2010). Measuring visibility to improve supply chain performance: A quantitative approach. Benchmarking, 17(4), 593–615.

Cottrill, K. (2000, Apr 17). The last mile. Journal of Commerce, pp. 19-19. Retrieved from http://search.proquest.com/docview/313479380?accountid=12702

Defense Transportation Regulation (DTR) Part II, Appendix CC (2008).

Retrieved from http://www.transcom.mil/dteb/files/refdata/V_D_ARPTNM_ARL_PO.htm

Germain, C. (2004). "Where's my order?" gaining visibility into last mile delivery. Materials Management and Distribution, 49(7), 31-31. Retrieved from http://search.proquest.com/docview/227966076?accountid=12702

Government Accountability Office (GAO). (2009, January). Lack of Key Information May Impede DOD’s Ability to Improve Supply Chain Management (GAO-09-150). Retrieved from http://www.gao.gov

Government Accountability Office (GAO). (2011, July). Defense Logistics: DoD Needs to Take Additional Actions to Address Challenges In Supply Chain Management (GAO-11-569). Retrieved from http://www.gao.gov

Government Accountability Office (GAO). (2011, February). High Risk Series: An Update (GAO-11-278). Retrieved from http://www.gao.gov

Hochberg, Y & Tamhane, A.C. (1987) Multiple Comparison Procedures. Hoboken, NJ: John Wiley & Sons.

Keller, G. (2005). Statistics for Management and Economics, Seventh Edition. Belmont, CA: Thomson Brooks/Cole.

Military Sealift Command. (n.d.). MSC Ship Inventory - USNS Lewis And Clark. Retrieved from http://www.msc.navy.mil/inventory/ships.asp?ship=116&type=DryCargoAmmunitionShip

NAVSUP P-409 - MILSTRIP/MILSTRAP Desk Guide, Part A – MILSTRIP. Retrieved from http://www.fmo.navy.mil/docs/REPORTING/dcm/NAVSUP_Publ-409_Condition_Codes.pdf

Naval Supply Systems Command (NAVSUP). (2011). Bahrain Challenges.ppt

O'Shea, W. (2009). Has last (mile) been least for too long? World Trade, WT 100, 22(3), 46-47. Retrieved from http://search.proquest.com/docview/228242890?accountid=12702

Trebilcock, B. (2010, VISIBILITY: Seeing clearly in the supply chain. Modern Materials Handling, 65(6), 38-41. Retrieved from http://search.proquest.com/docview/903303468?accountid=12702

United States Central Command [USCENTCOM]. (n.d.). About U.S. Central Command (CENTCOM). Retrieved from http://www.centcom.mil/about-u-s-central-command-centcom

United States Navy. (2007a, 15 January). The U.S. Navy -- C-40A Clipper logistics aircraft. Retrieved from http://www.navy.mil/navydata/fact_display.asp?cid=1100&tid=600&ct=1

United States Navy. (2009a, 17 February). Navy News Service - Eye on the Fleet. Retrieved from http://www.navy.mil/view_single.asp?id=42164

United States Navy. (2009b, 17 February). The U.S. Navy -- C-130 Hercules logistics aircraft. Retrieved from http://www.navy.mil/navydata/fact_display.asp?cid=1100&tid=500&ct=1

United States Navy. (2002, 12 February). Navy News Service - Eye on the Fleet. Retrieved from http://www.navy.mil/view_single.asp?id=833

United States Navy. (2001, 18 December). Navy News Service - Eye on the Fleet. Retrieved from http://www.navy.mil/view_single.asp?id=360

World Airport Codes. (n.d.) Retrieved from http://www.world-airport-codes.com/

United States Navy. (2009c, 17 February). The U.S. Navy -- C-2A Greyhound logistics aircraft. Retrieved from http://www.navy.mil/navydata/fact_display.asp?cid=1100&tid=100&ct=1

United States Navy. (2009d, 20 February). The U.S. Navy -- SH-60 Seahawk helicopter. Retrieved from http://www.navy.mil/navydata/fact_display.asp?cid=1200&tid=500&ct=1

United States Navy. (2007b, 22 August). The U.S. Navy -- Fleet Replenishment Oilers - T-AO. Retrieved from http://www.navy.mil/navydata/fact_display.asp?cid=4400&tid=600&ct=4

United States Navy. (2004a, 20 July). Navy News Service - Eye on the Fleet. Retrieved from http://www.navy.mil/view_single.asp?id=16429

United States Navy. (2004b, 16 July). Navy News Service - Eye on the Fleet. Retrieved from http://www.navy.mil/view_single.asp?id=16295

United States Navy. (2004c, 6 August). Navy News Service - Eye on the Fleet. Retrieved from http://www.navy.mil/view_single.asp?id=16882

United States Navy. (2004d, 21 December). Navy News Service - Eye on the Fleet. Retrieved from http://www.navy.mil/view_single.asp?id=19754

Wei-hua, L., Xue-cai, X., Zheng-xu, R., & Peng, Y. (2011). An emergency order allocation model based on multi-provider in two-echelon logistics service supply chain. Supply Chain Management, 16(6), 391–400.

THIS PAGE INTENTIONALLY LEFT BLANK

INITIAL DISTRIBUTION LIST

1. Defense Technical Information Center
   Ft. Belvoir, Virginia

2. Dudley Knox Library
   Naval Postgraduate School
   Monterey, California

3. Naval Supply Systems Command
   Mechanicsburg, Pennsylvania